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EOD Head-End Access Architecture

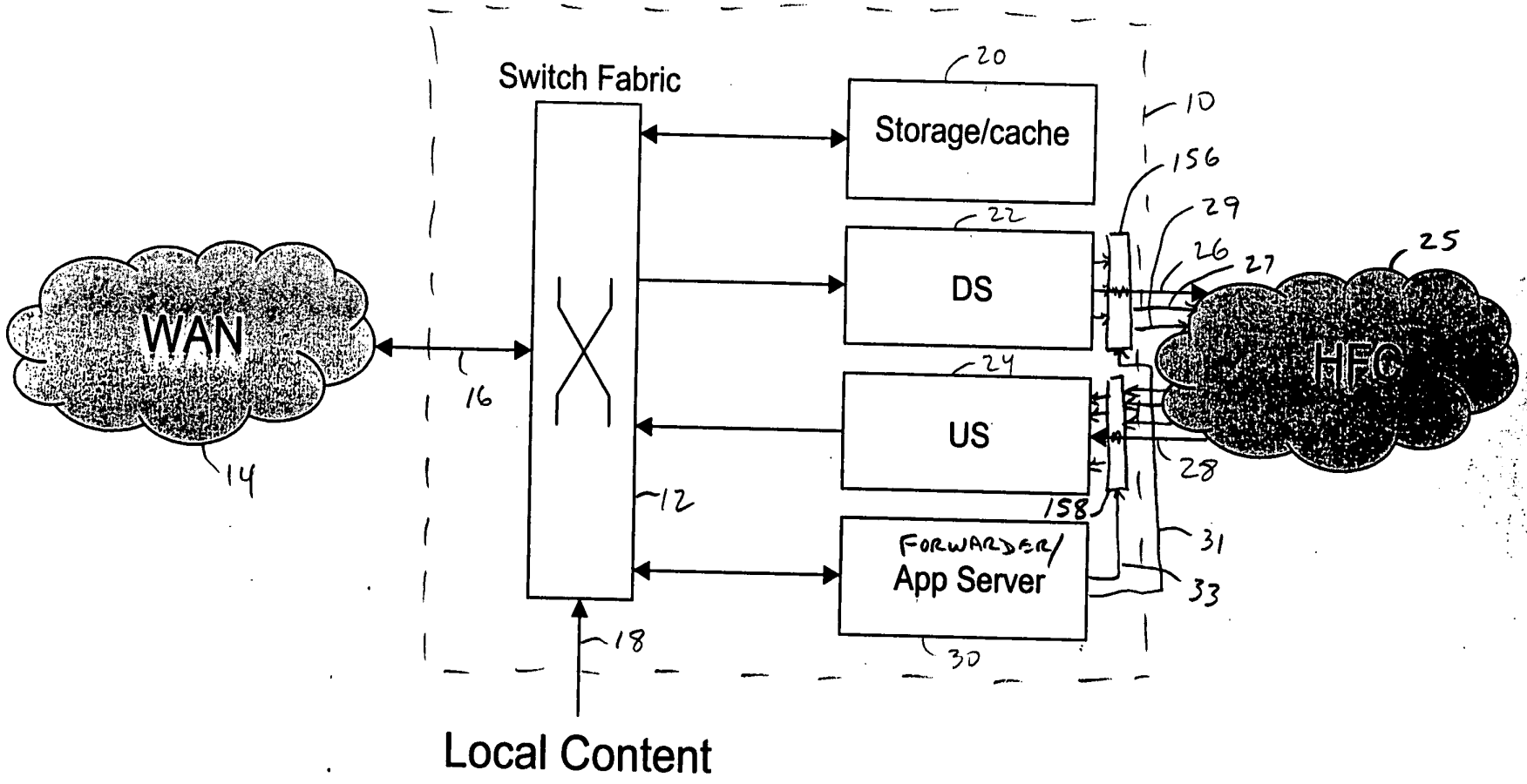


FIG. 1

DOCSIS Data & Control messages path

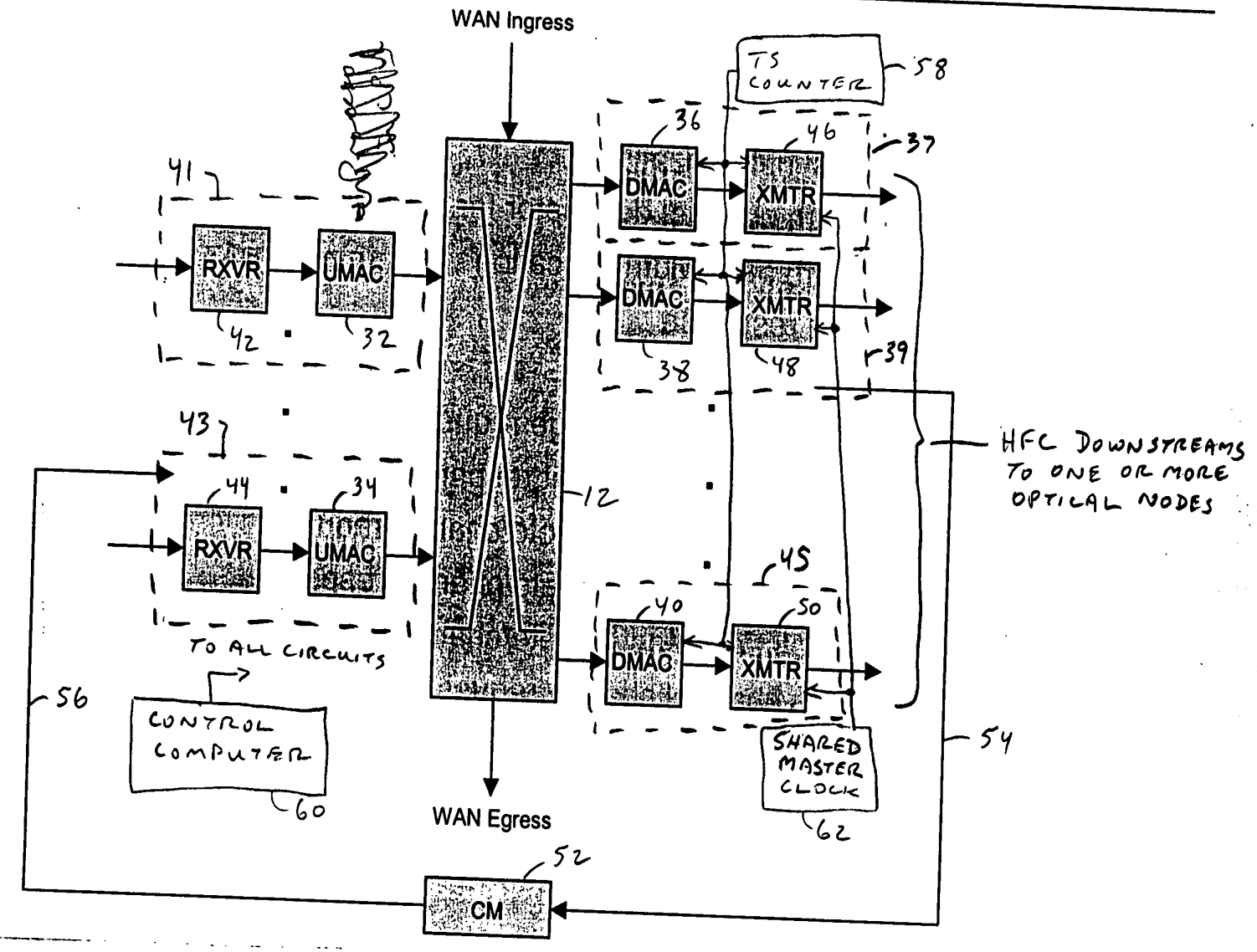


FIG. 2

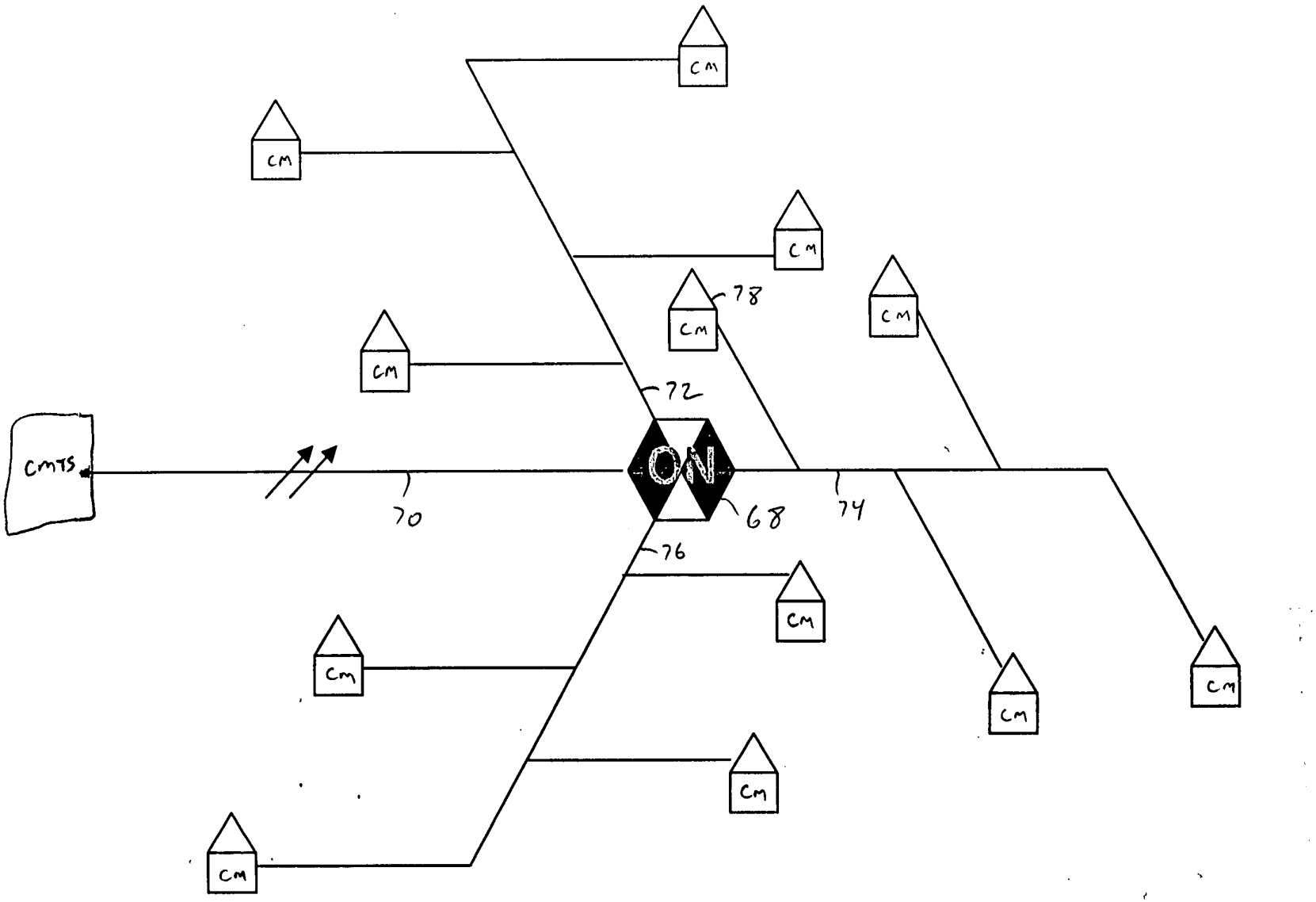


FIG. 3

HFC Network – Star Topology

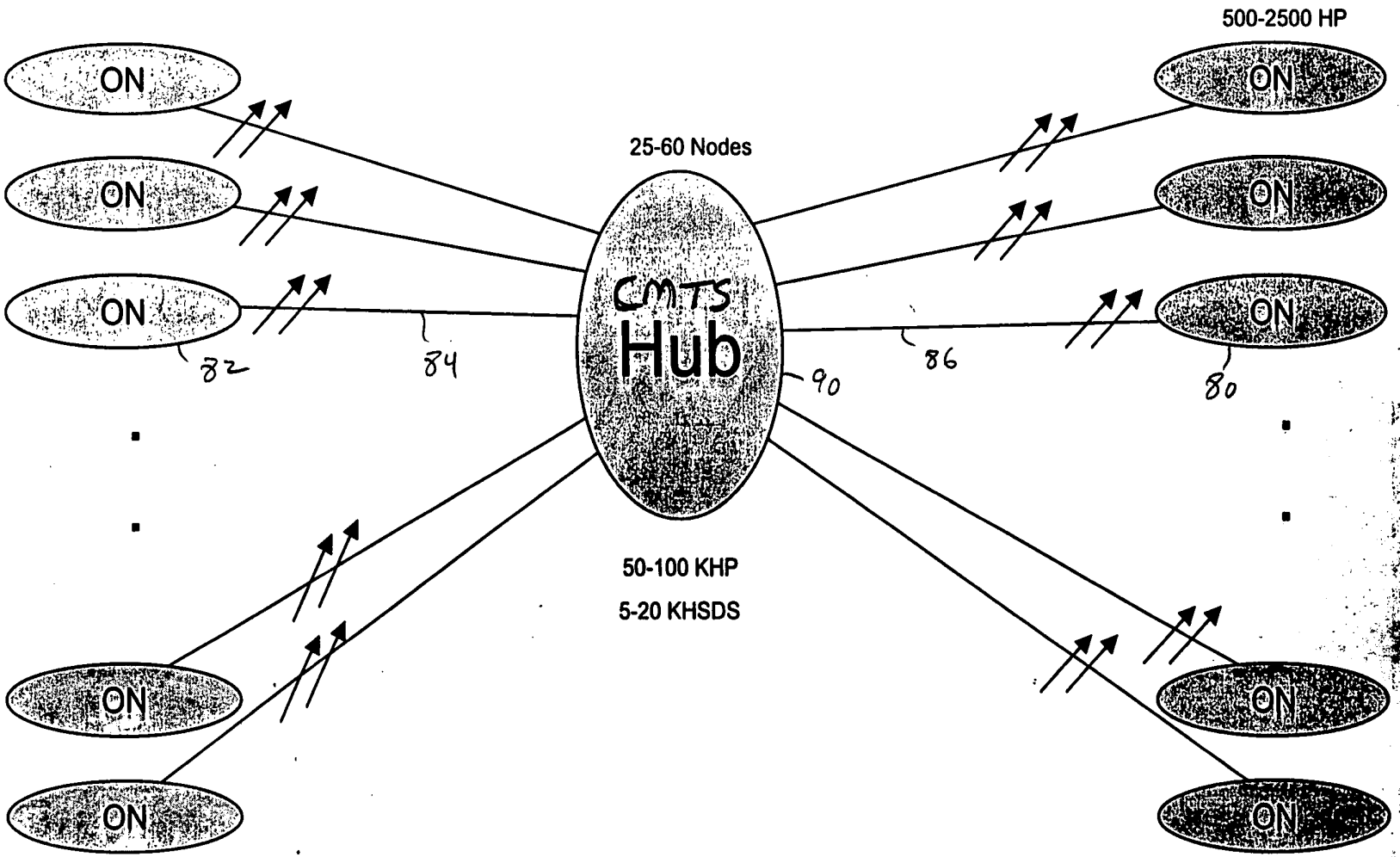


FIG. 4

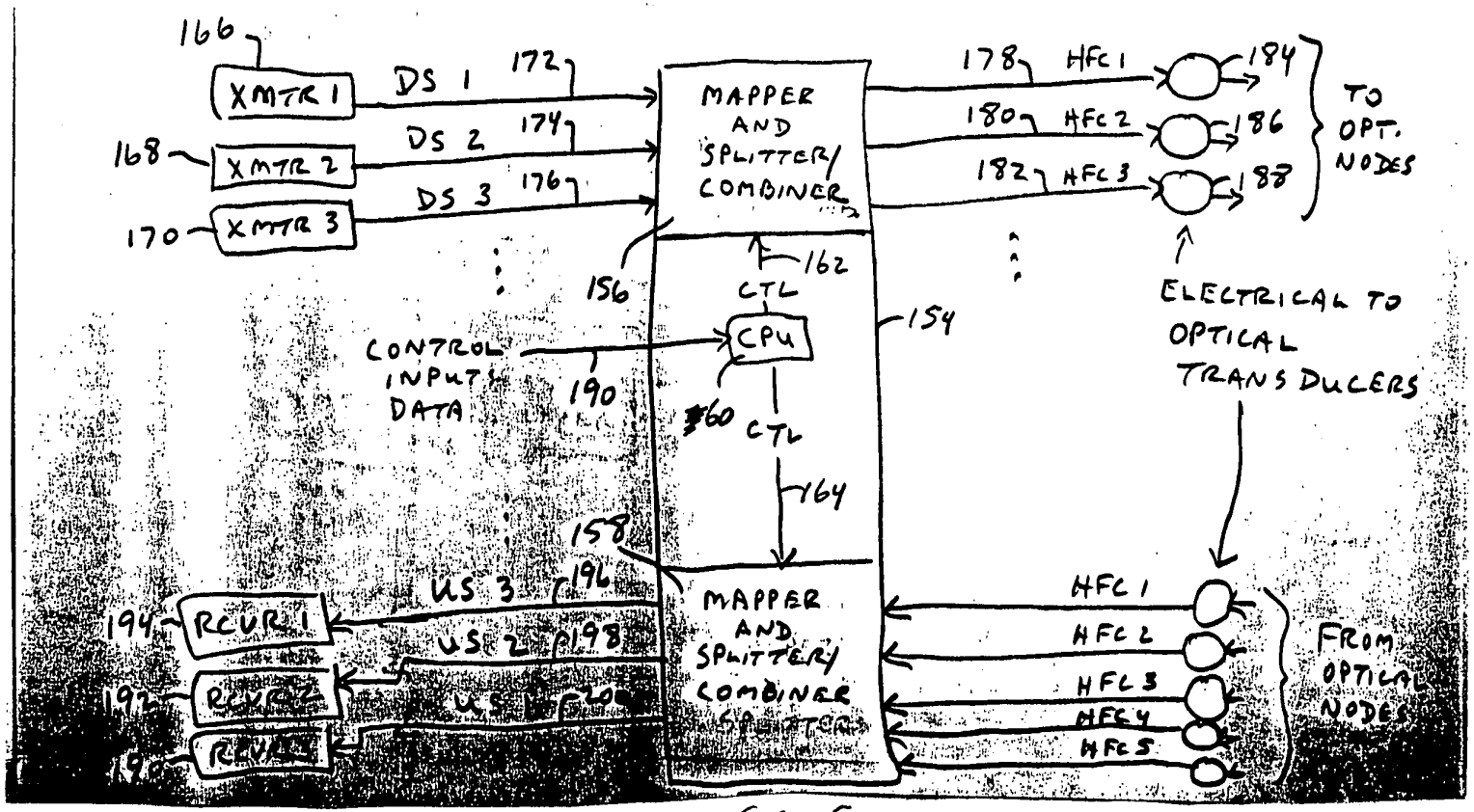

166
XMTR 1
DS 1
172
168
XMTR 2
DS 2
174
170
XMTR 3
DS 3
176
MAPPER AND SPLITTER/ COMBINER
178
HFC 1
184
180
HFC 2
186
182
HFC 3
188
TO OPT. NODES
156
162
CTL
CPU
154
CONTROL INPUT DATA
190
160
CTL
164
ELECTRICAL TO OPTICAL TRANSDUCERS
158
US 3
196
194
RCVR 1
US 2
198
192
RCVR 2
US 1
200
190
RCVR 3
MAPPER AND SPLITTER/ COMBINER
HFC 1
HFC 2
HFC 3
HFC 4
HFC 5
FROM OPTICAL NODES

FIG. 5

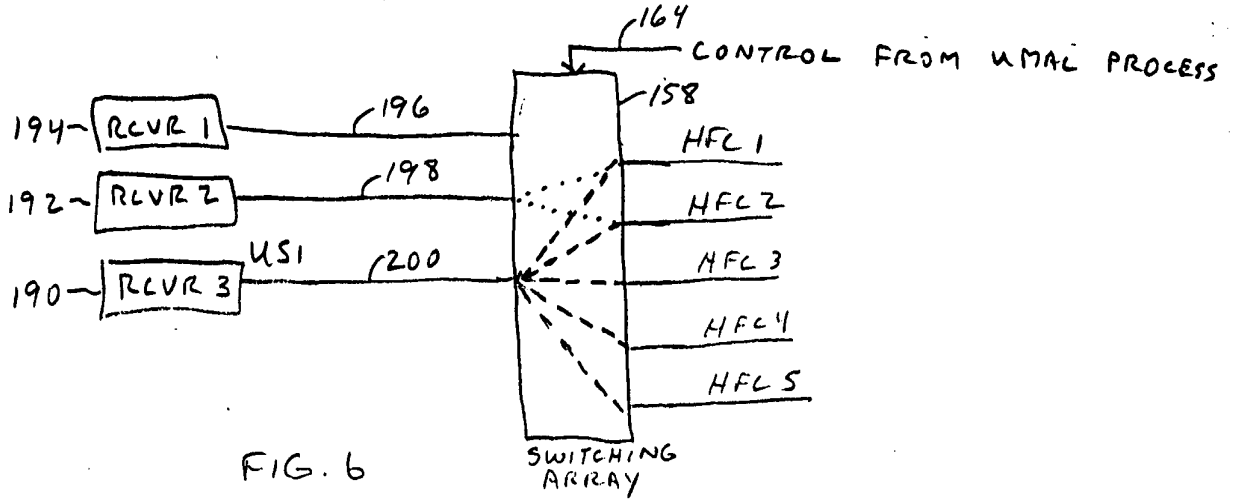

164
CONTROL FROM UMAL PROCESS
158
194
RCVR 1
196
HFC 1
192
RCVR 2
198
HFC 2
190
RCVR 3
US1
200
HFC 3
HFC 4
HFC 5
SWITCHING ARRAY

FIG. 6

Non Overlapping bursts over multiple nodes

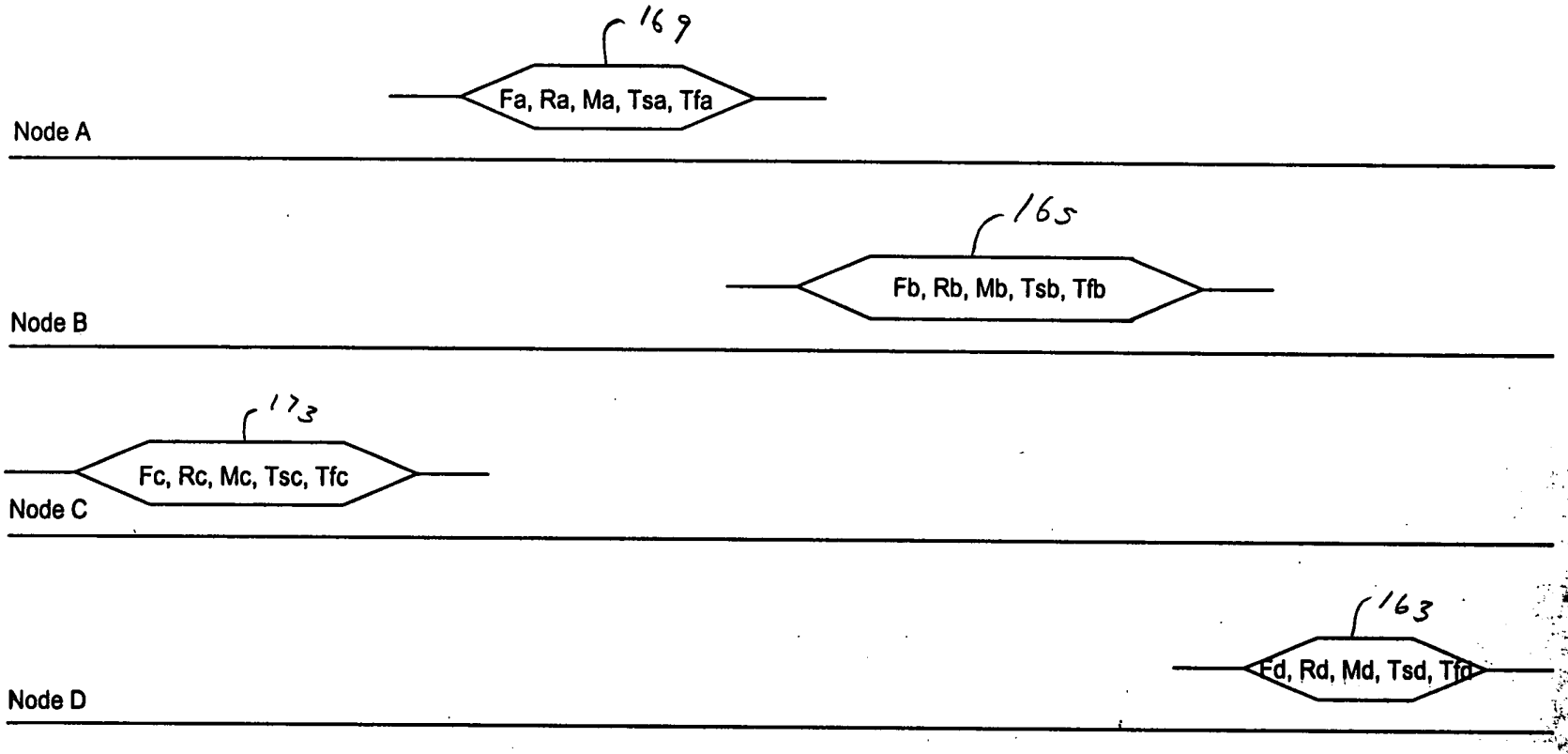


FIG. 7

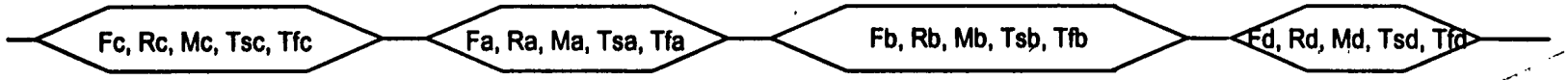


FIG. 8

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

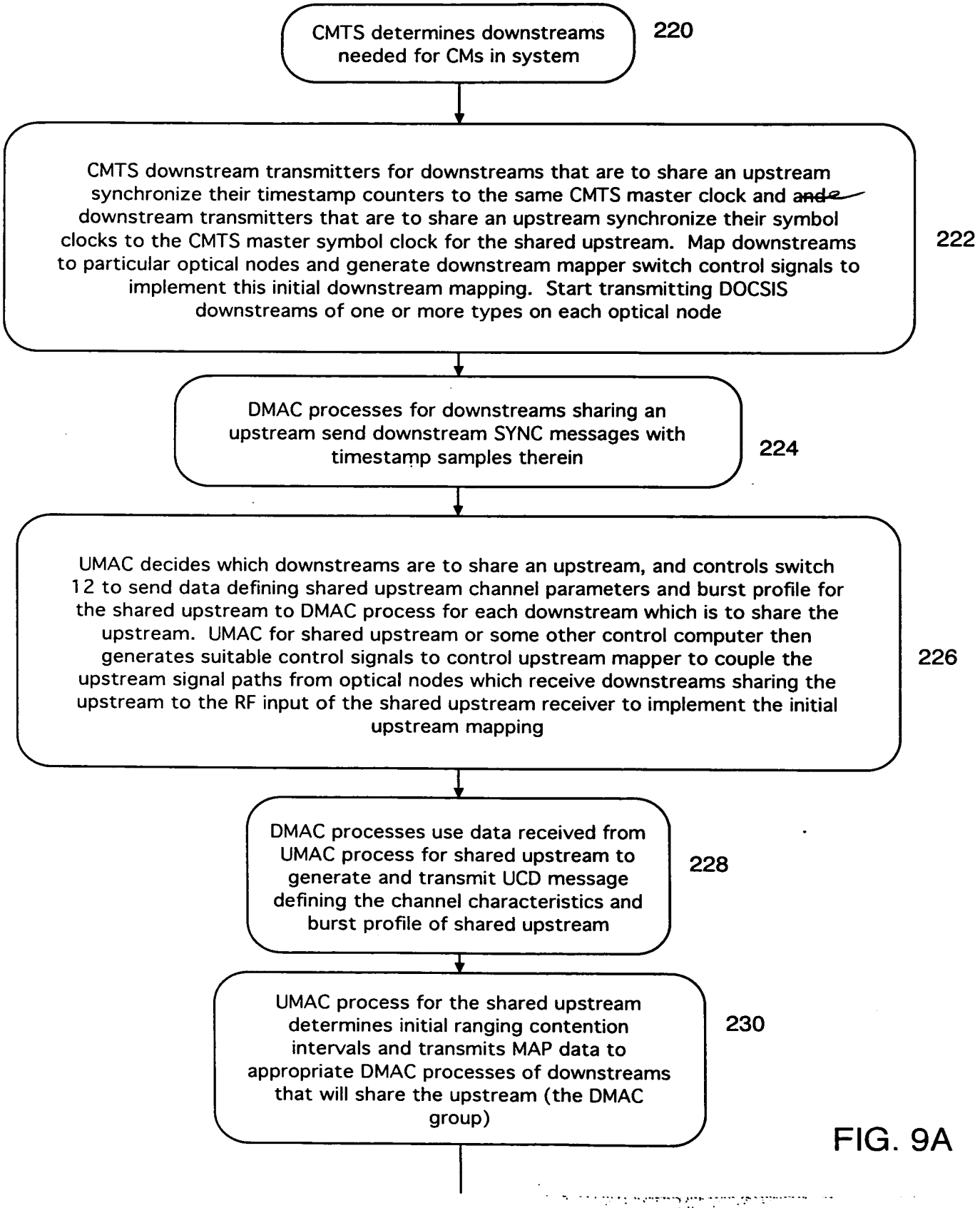
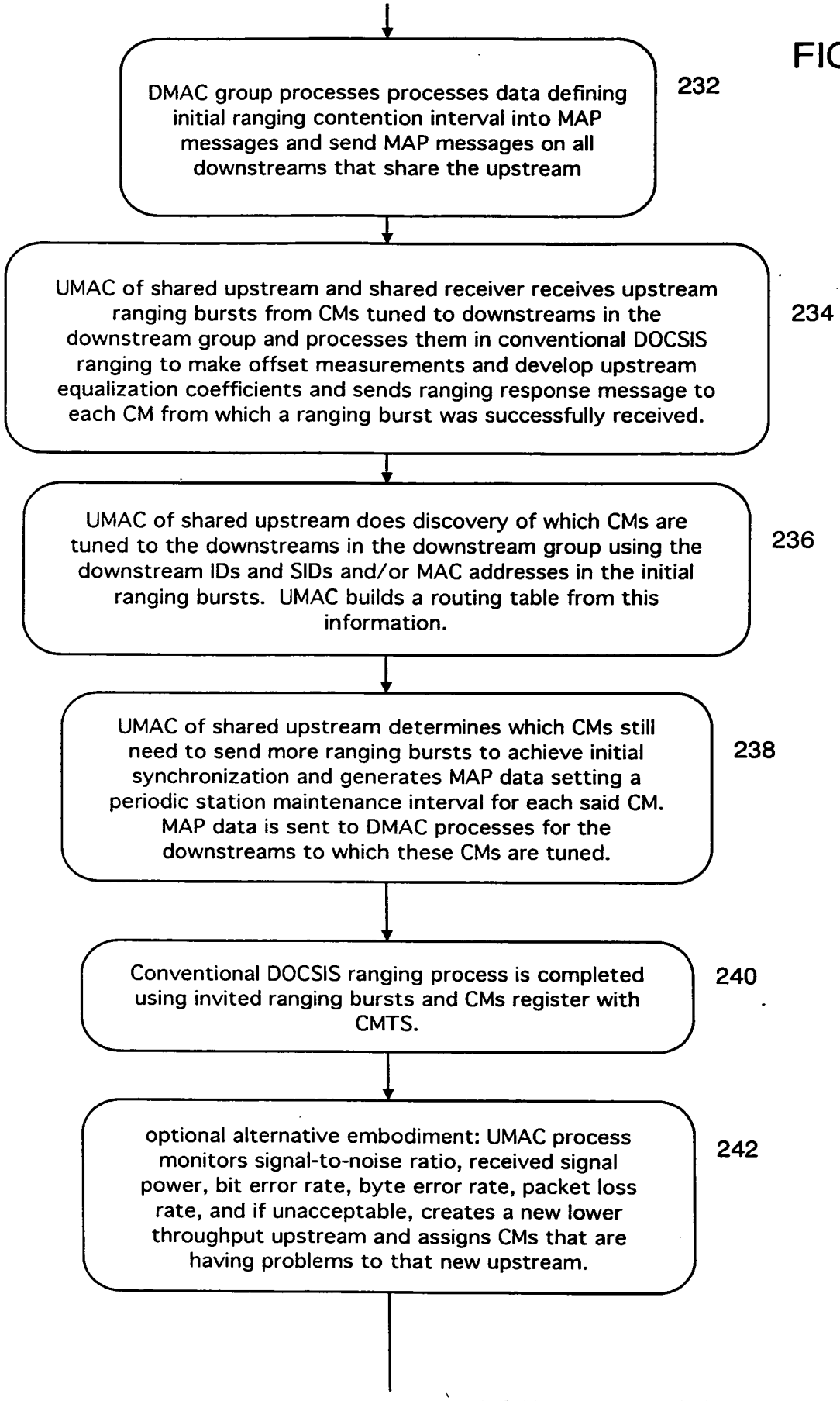


FIG. 9A

FIG. 9B


DMAC group processes processes data defining initial ranging contention interval into MAP messages and send MAP messages on all downstreams that share the upstream
232
UMAC of shared upstream and shared receiver receives upstream ranging bursts from CMs tuned to downstreams in the downstream group and processes them in conventional DOCSIS ranging to make offset measurements and develop upstream equalization coefficients and sends ranging response message to each CM from which a ranging burst was successfully received.
234
UMAC of shared upstream does discovery of which CMs are tuned to the downstreams in the downstream group using the downstream IDs and SIDs and/or MAC addresses in the initial ranging bursts. UMAC builds a routing table from this information.
236
UMAC of shared upstream determines which CMs still need to send more ranging bursts to achieve initial synchronization and generates MAP data setting a periodic station maintenance interval for each said CM. MAP data is sent to DMAC processes for the downstreams to which these CMs are tuned.
238
Conventional DOCSIS ranging process is completed using invited ranging bursts and CMs register with CMTS.
240
optional alternative embodiment: UMAC process monitors signal-to-noise ratio, received signal power, bit error rate, byte error rate, packet loss rate, and if unacceptable, creates a new lower throughput upstream and assigns CMs that are having problems to that new upstream.
242

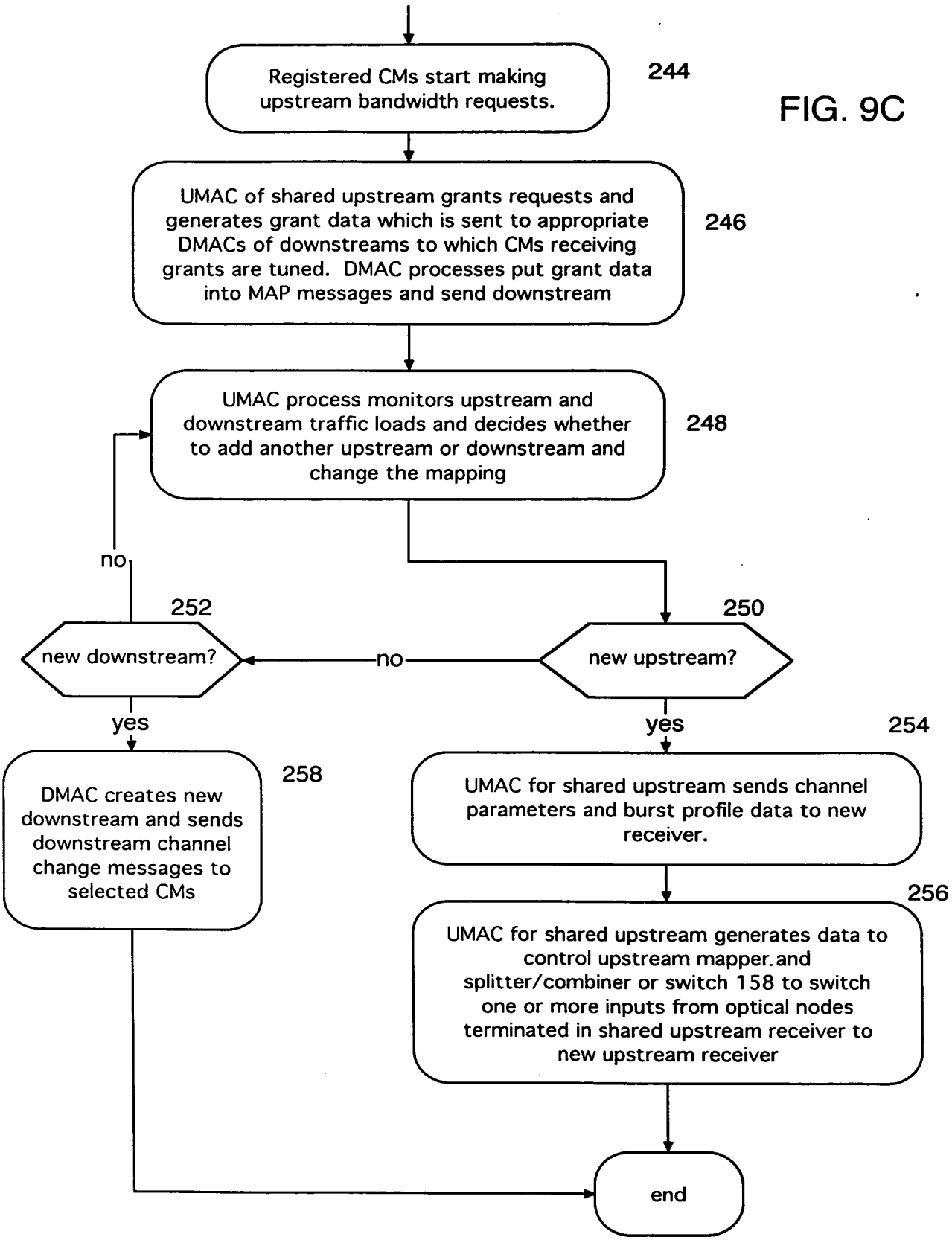

Registered CMs start making upstream bandwidth requests.
244
UMAC of shared upstream grants requests and generates grant data which is sent to appropriate DMACs of downstreams to which CMs receiving grants are tuned. DMAC processes put grant data into MAP messages and send downstream
246
UMAC process monitors upstream and downstream traffic loads and decides whether to add another upstream or downstream and change the mapping
248
no
252
new downstream?
no
250
new upstream?
yes
yes
254
DMAC creates new downstream and sends downstream channel change messages to selected CMs
258
UMAC for shared upstream sends channel parameters and burst profile data to new receiver.
256
UMAC for shared upstream generates data to control upstream mapper and splitter/combiner or switch 158 to switch one or more inputs from optical nodes terminated in shared upstream receiver to new upstream receiver
end

FIG. 9C

PROCESS TO CREATE AND CHANGE US/DS MAPPING IN THE PRESENCE OF NOISE AGGREGATION

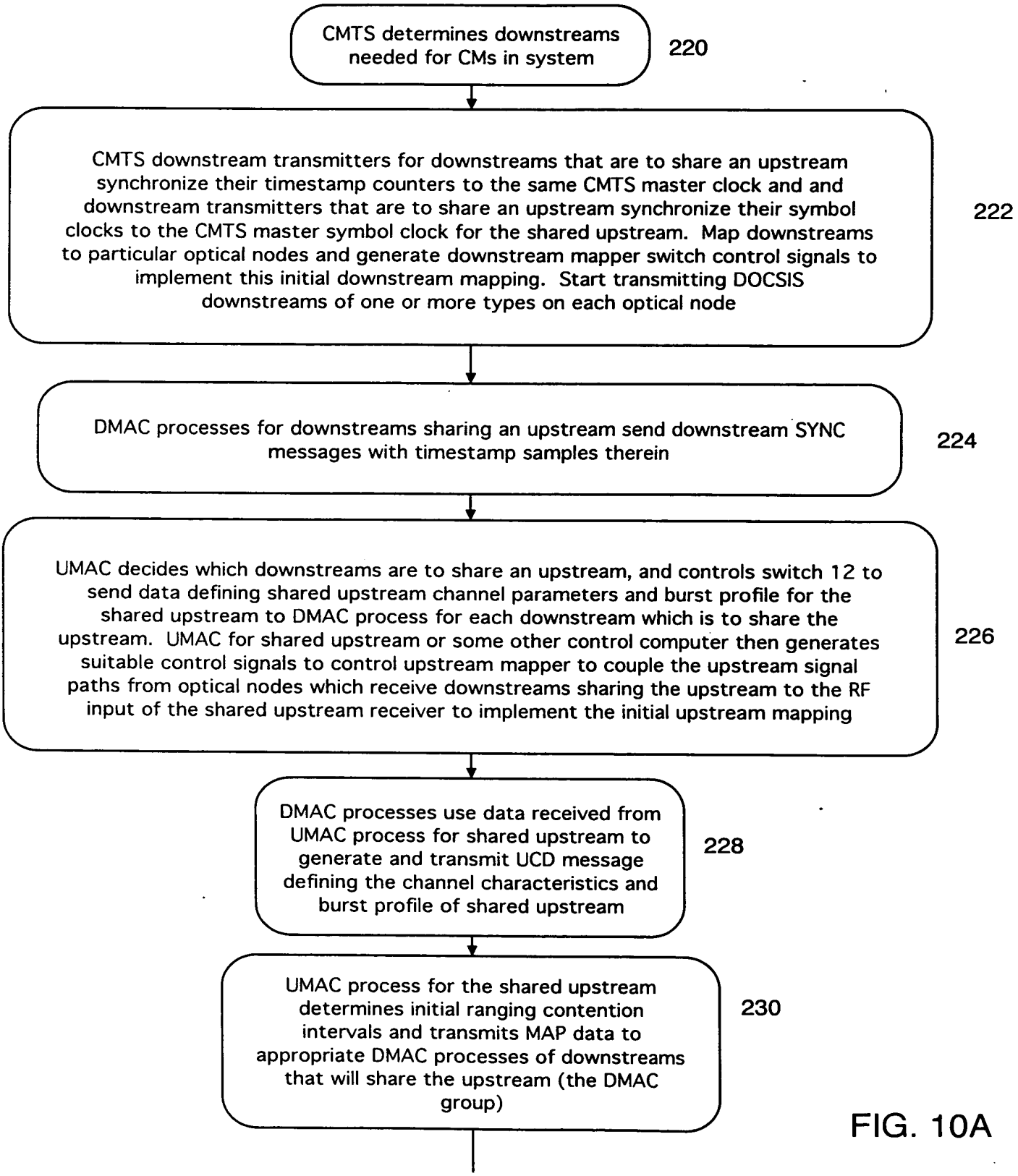


FIG. 10A

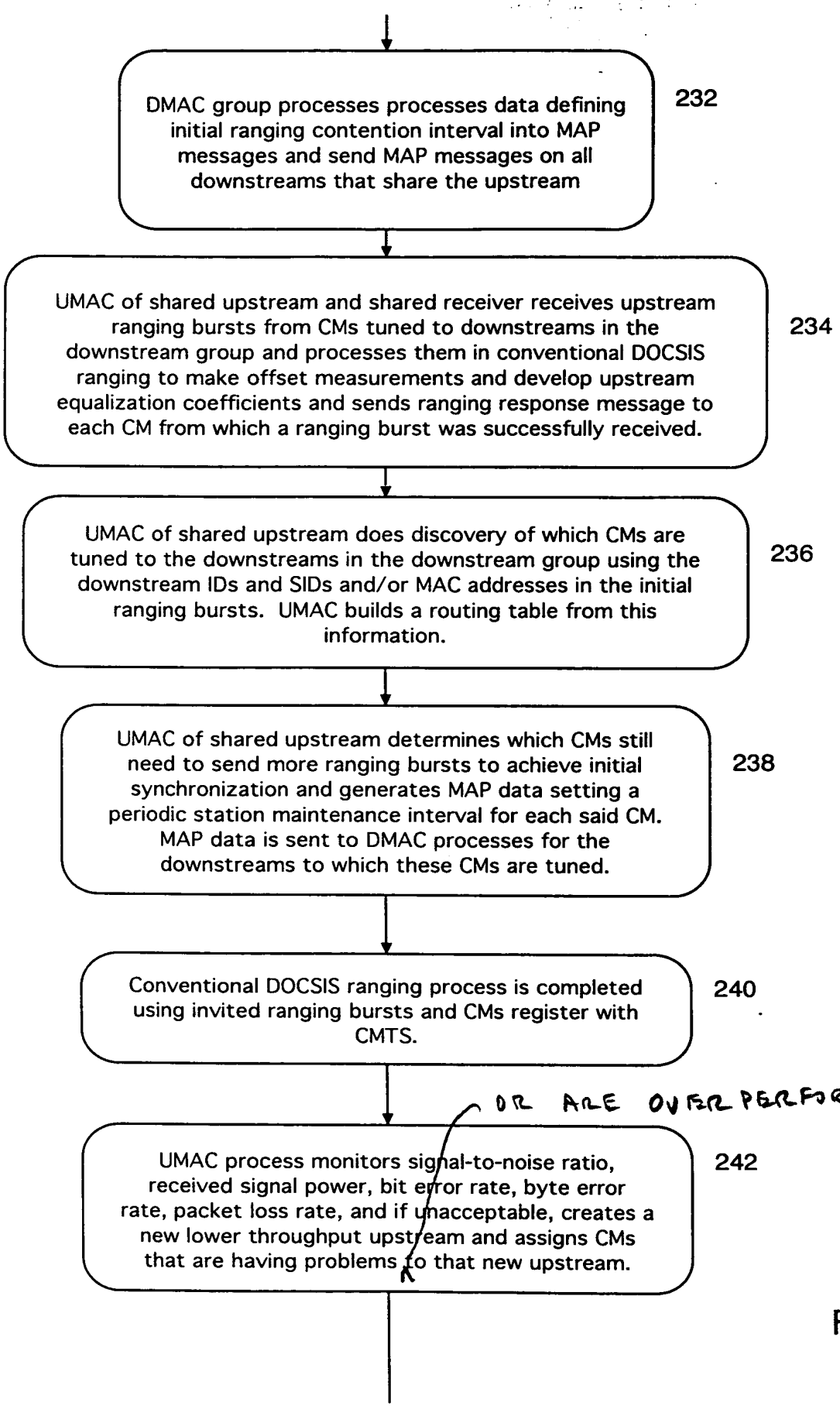

DMAC group processes processes data defining initial ranging contention interval into MAP messages and send MAP messages on all downstreams that share the upstream
232
UMAC of shared upstream and shared receiver receives upstream ranging bursts from CMs tuned to downstreams in the downstream group and processes them in conventional DOCSIS ranging to make offset measurements and develop upstream equalization coefficients and sends ranging response message to each CM from which a ranging burst was successfully received.
234
UMAC of shared upstream does discovery of which CMs are tuned to the downstreams in the downstream group using the downstream IDs and SIDs and/or MAC addresses in the initial ranging bursts. UMAC builds a routing table from this information.
236
UMAC of shared upstream determines which CMs still need to send more ranging bursts to achieve initial synchronization and generates MAP data setting a periodic station maintenance interval for each said CM. MAP data is sent to DMAC processes for the downstreams to which these CMs are tuned.
238
Conventional DOCSIS ranging process is completed using invited ranging bursts and CMs register with CMTS.
240
OR ARE OVERPERFORMING
UMAC process monitors signal-to-noise ratio, received signal power, bit error rate, byte error rate, packet loss rate, and if unacceptable, creates a new lower throughput upstream and assigns CMs that are having problems to that new upstream.
242

FIG. 10B

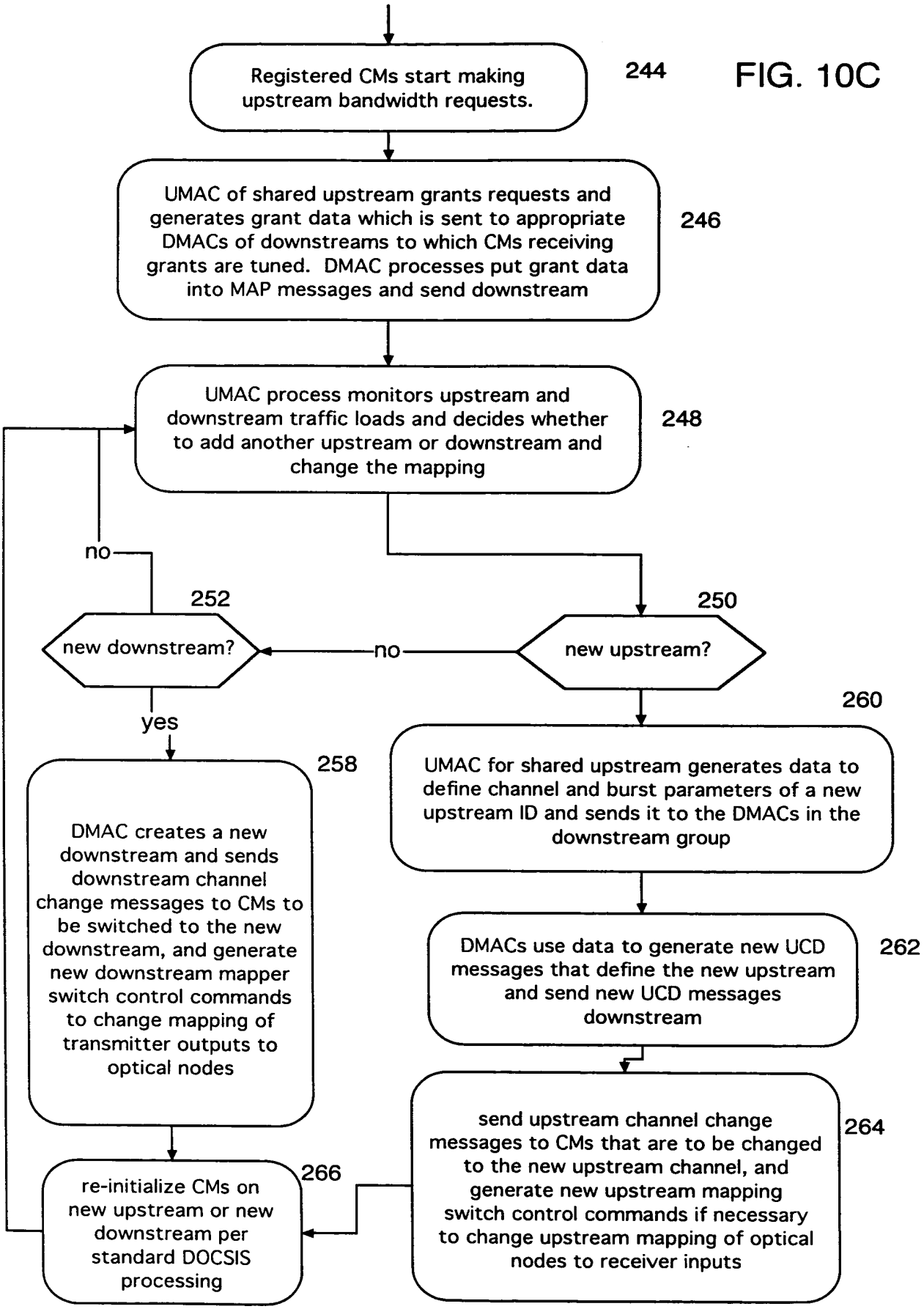

Registered CMs start making upstream bandwidth requests.
244
UMAC of shared upstream grants requests and generates grant data which is sent to appropriate DMACs of downstreams to which CMs receiving grants are tuned. DMAC processes put grant data into MAP messages and send downstream
246
UMAC process monitors upstream and downstream traffic loads and decides whether to add another upstream or downstream and change the mapping
248
no
252
new downstream?
no
250
new upstream?
yes
260
UMAC for shared upstream generates data to define channel and burst parameters of a new upstream ID and sends it to the DMACs in the downstream group
258
DMAC creates a new downstream and sends downstream channel change messages to CMs to be switched to the new downstream, and generate new downstream mapper switch control commands to change mapping of transmitter outputs to optical nodes
DMACs use data to generate new UCD messages that define the new upstream and send new UCD messages downstream
262
send upstream channel change messages to CMs that are to be changed to the new upstream channel, and generate new upstream mapping switch control commands if necessary to change upstream mapping of optical nodes to receiver inputs
264
266
re-initialize CMs on new upstream or new downstream per standard DOCSIS processing

FIG. 10C

PROCESS TO CREATE AND CHANGE US/DS MAPPING ~~IN THE PRESENCE OF~~ WITHOUT NOISE AGGREGATION

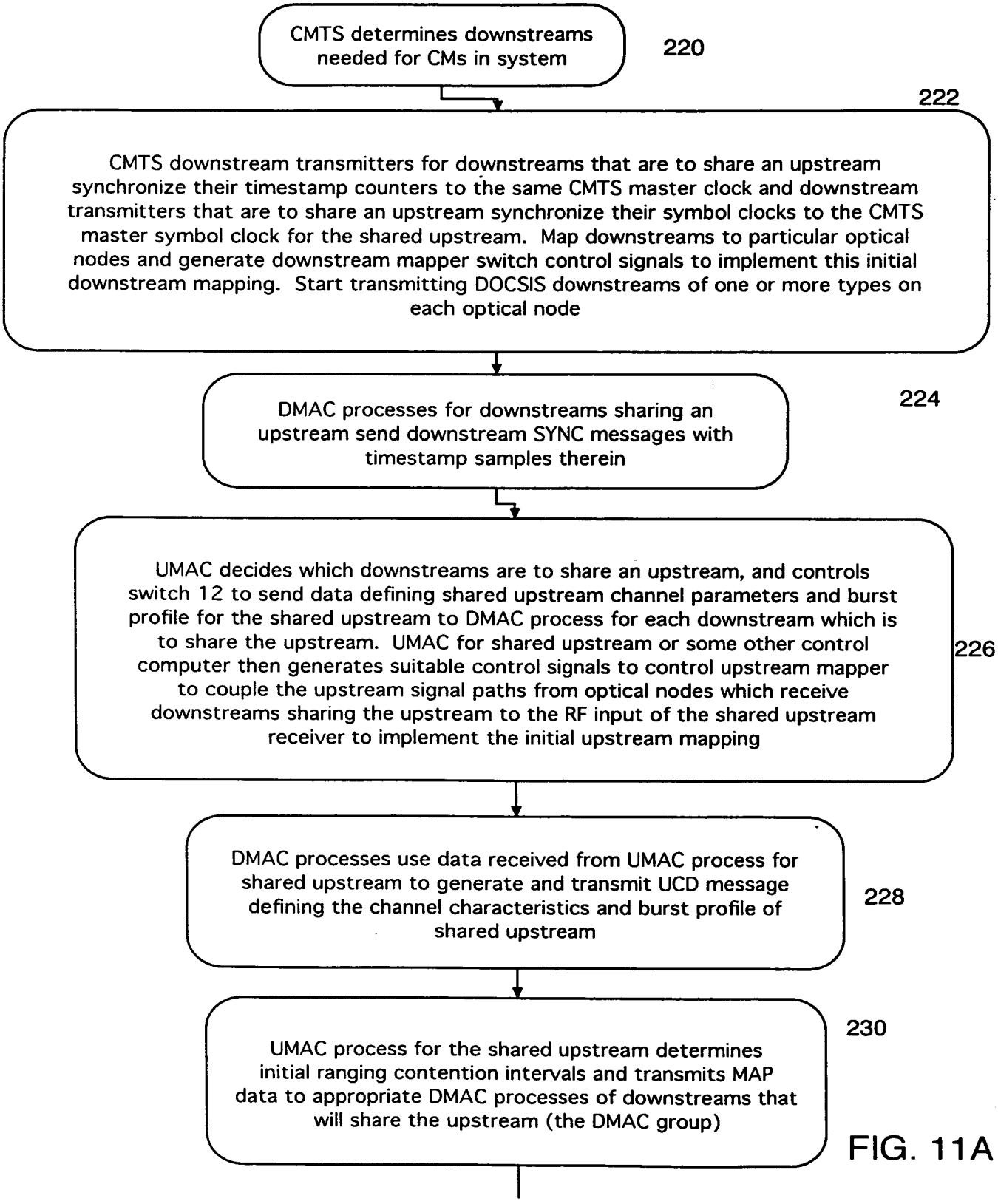


FIG. 11A

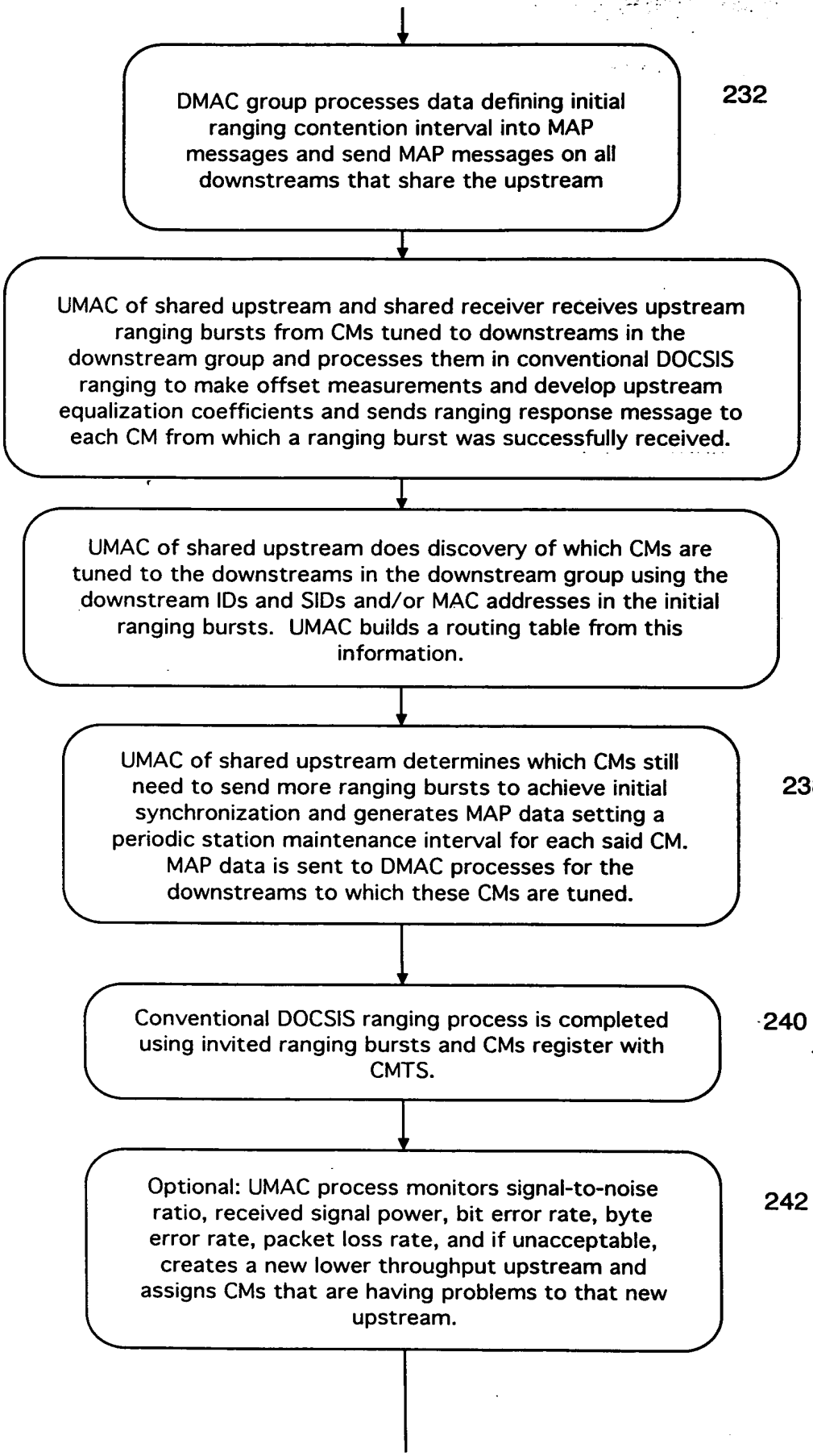
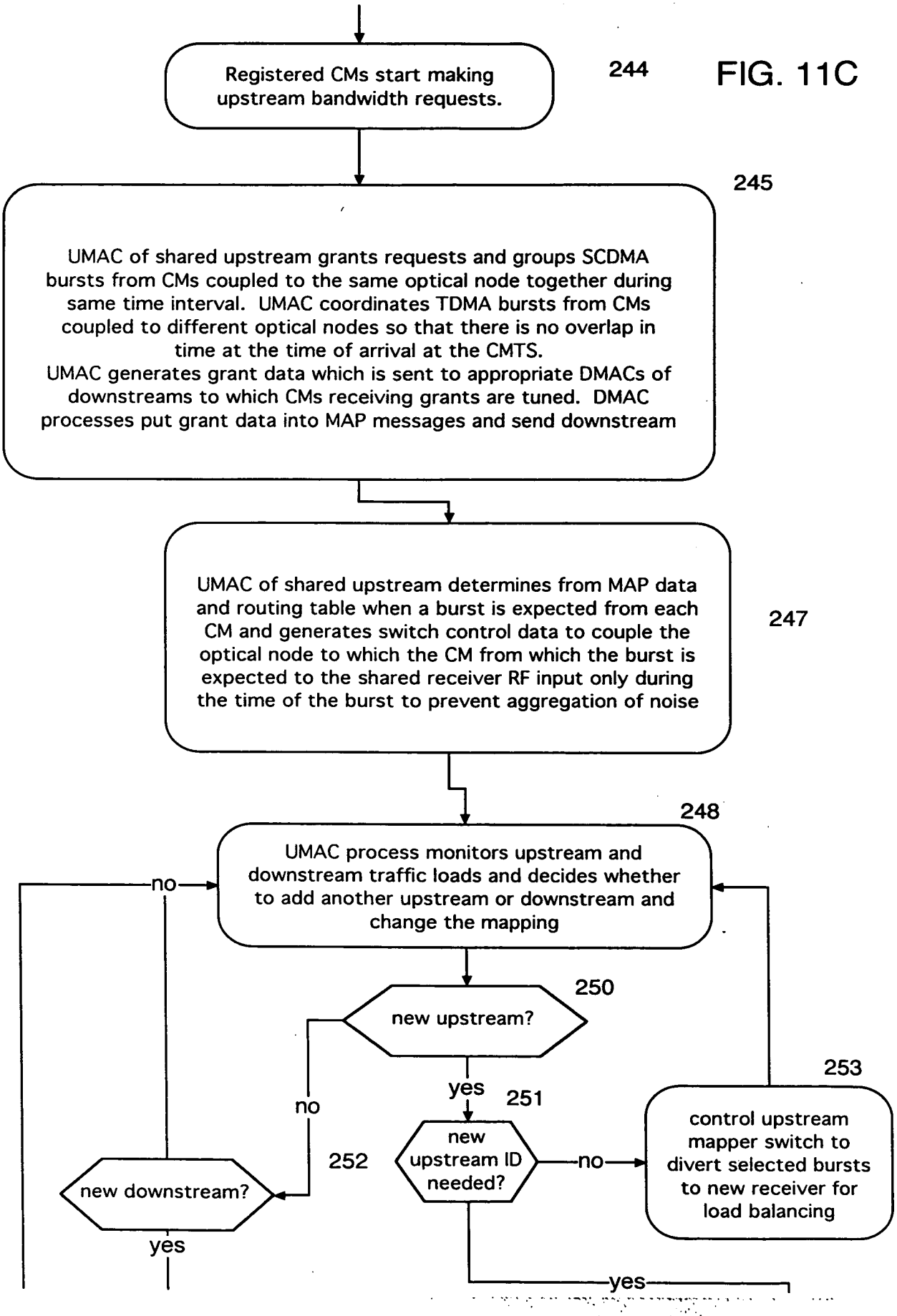

DMAC group processes data defining initial ranging contention interval into MAP messages and send MAP messages on all downstreams that share the upstream
232
UMAC of shared upstream and shared receiver receives upstream ranging bursts from CMs tuned to downstreams in the downstream group and processes them in conventional DOCSIS ranging to make offset measurements and develop upstream equalization coefficients and sends ranging response message to each CM from which a ranging burst was successfully received.
234
UMAC of shared upstream does discovery of which CMs are tuned to the downstreams in the downstream group using the downstream IDs and SIDs and/or MAC addresses in the initial ranging bursts. UMAC builds a routing table from this information.
236
UMAC of shared upstream determines which CMs still need to send more ranging bursts to achieve initial synchronization and generates MAP data setting a periodic station maintenance interval for each said CM. MAP data is sent to DMAC processes for the downstreams to which these CMs are tuned.
238
Conventional DOCSIS ranging process is completed using invited ranging bursts and CMs register with CMTS.
240
Optional: UMAC process monitors signal-to-noise ratio, received signal power, bit error rate, byte error rate, packet loss rate, and if unacceptable, creates a new lower throughput upstream and assigns CMs that are having problems to that new upstream.
242

FIG. 11B


Registered CMs start making upstream bandwidth requests.
244
FIG. 11C
245
UMAC of shared upstream grants requests and groups SCDMA bursts from CMs coupled to the same optical node together during same time interval. UMAC coordinates TDMA bursts from CMs coupled to different optical nodes so that there is no overlap in time at the time of arrival at the CMTS.
UMAC generates grant data which is sent to appropriate DMACs of downstreams to which CMs receiving grants are tuned. DMAC processes put grant data into MAP messages and send downstream
UMAC of shared upstream determines from MAP data and routing table when a burst is expected from each CM and generates switch control data to couple the optical node to which the CM from which the burst is expected to the shared receiver RF input only during the time of the burst to prevent aggregation of noise
247
248
UMAC process monitors upstream and downstream traffic loads and decides whether to add another upstream or downstream and change the mapping
no
250
new upstream?
yes
251
no
new upstream ID needed?
no
253
control upstream mapper switch to divert selected bursts to new receiver for load balancing
252
new downstream?
yes
yes

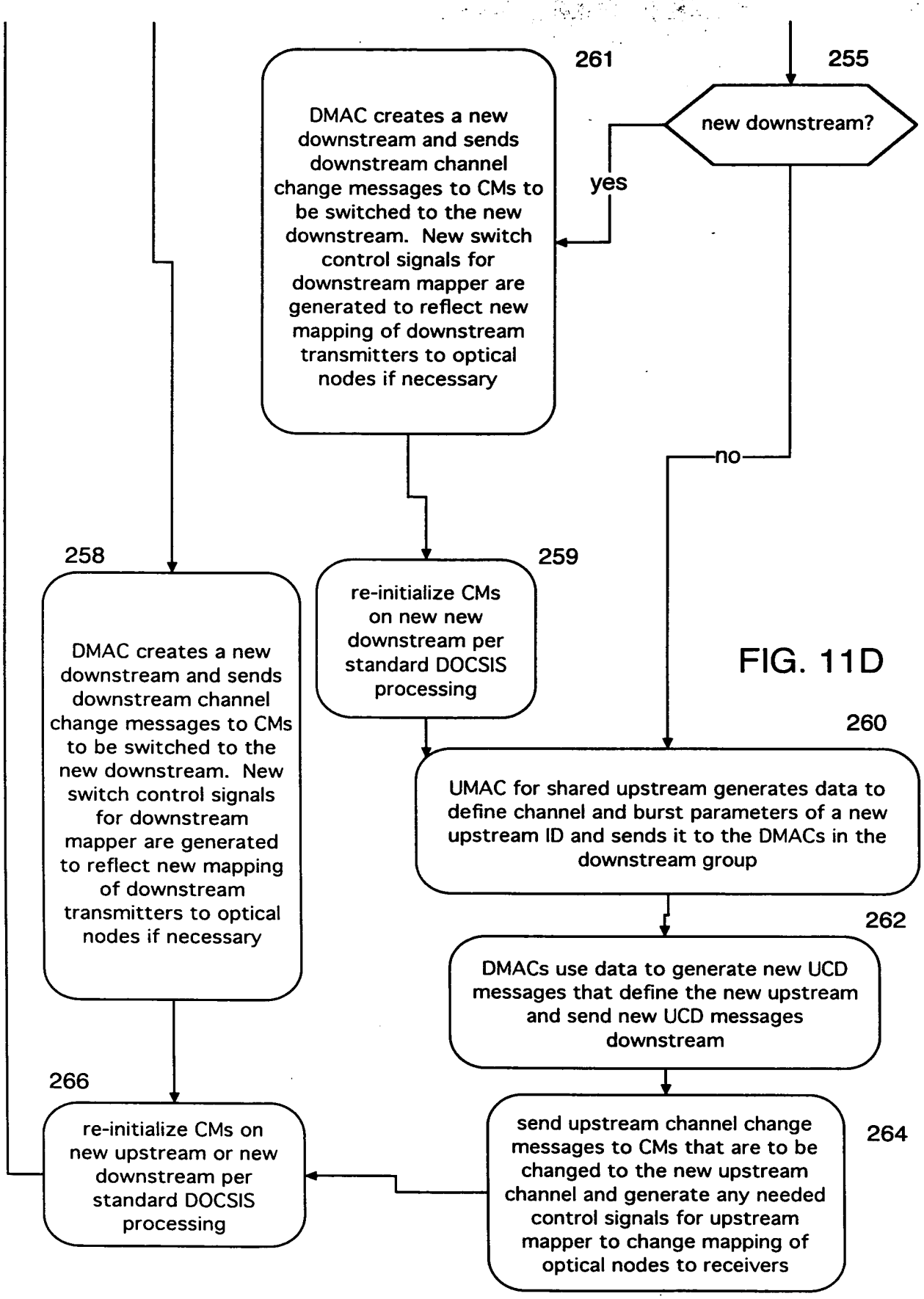

255
new downstream?
yes
no
261
DMAC creates a new downstream and sends downstream channel change messages to CMs to be switched to the new downstream. New switch control signals for downstream mapper are generated to reflect new mapping of downstream transmitters to optical nodes if necessary
259
re-initialize CMs on new new downstream per standard DOCSIS processing
258
DMAC creates a new downstream and sends downstream channel change messages to CMs to be switched to the new downstream. New switch control signals for downstream mapper are generated to reflect new mapping of downstream transmitters to optical nodes if necessary
260
UMAC for shared upstream generates data to define channel and burst parameters of a new upstream ID and sends it to the DMACs in the downstream group
262
DMACs use data to generate new UCD messages that define the new upstream and send new UCD messages downstream
264
send upstream channel change messages to CMs that are to be changed to the new upstream channel and generate any needed control signals for upstream mapper to change mapping of optical nodes to receivers
266
re-initialize CMs on new upstream or new downstream per standard DOCSIS processing

FIG. 11D

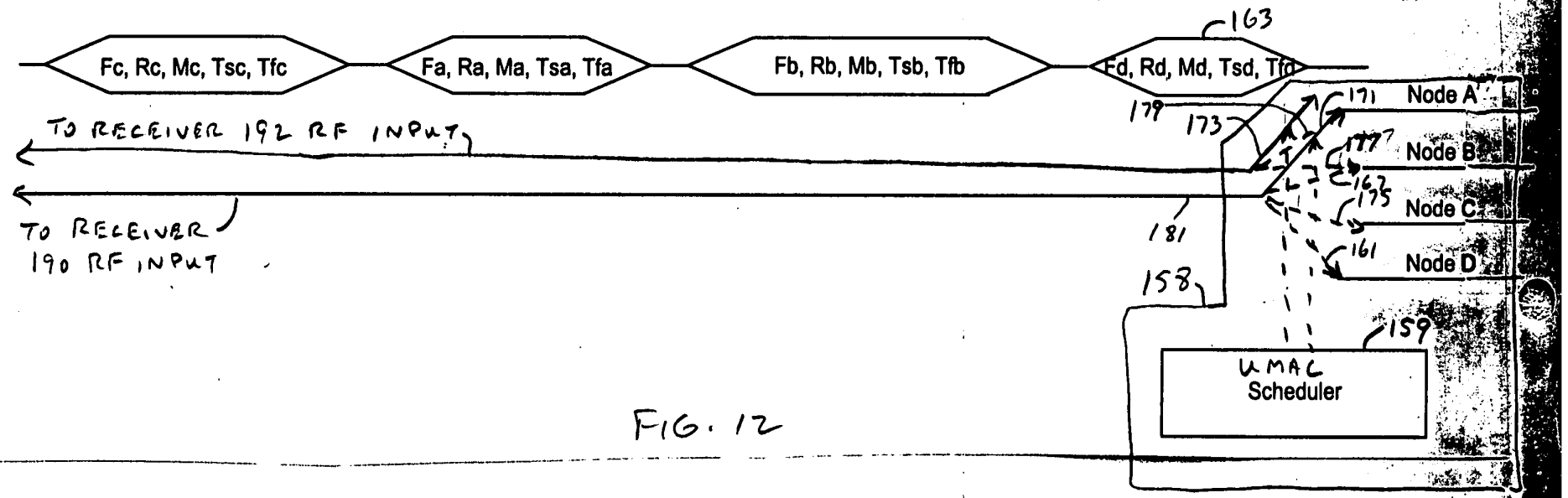

Fc, Rc, Mc, Tsc, Tfc
Fa, Ra, Ma, Tsa, Tfa
Fb, Rb, Mb, Tsb, Tfb
Fd, Rd, Md, Tsd, Tfd
163
TO RECEIVER 192 RF INPUT
TO RECEIVER 190 RF INPUT
179
173
181
171
Node A
177
Node B
167
175
Node C
161
Node D
158
159
UMAC Scheduler

FIG. 12